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X. *Experiments and Observations on the Gymnotus Electricus, or Electrical Eel.* By Hugh Williamson, M. D.
Communicated by John Walsh, Esq. F. R. S.

TO JOHN WALSH, ESQ.

SIR,

London Feb. 7, 1775-

Redde, Feb. 9,
1775

AS the electrical eel has lately engaged the public attention, and yours in particular, I have taken the liberty of sending you some experiments which I made on that fish: they are the same that I had the pleasure of shewing you last winter, on my arrival from Pennsylvania. If you apprehend they may tend to cast any light on that curious part of natural history, or to gratify the curiosity of the public, be pleased to make any use of them you may think proper. Besides my own superficial acquaintance with the subject of electricity, of which I am very conscious, there are other circumstances that may help to apologize for the imperfect state in which these experiments appear. The eel being sickened by the change of climate, its owner refused to let us take it out of the water, for the purpose of making experiments, on reasonable terms; and there were many experiments which I could not
make

make on it in the water, to my own satisfaction. While I made these experiments, the eel was kept in a large vessel, supported by pieces of dry timber, about three feet above the floor. Perhaps it may deserve notice, that a small hole being bored in the vessel in which the eel was swimming, one person provoked the eel so as to receive a shock; another person at the same time, not in contact with him, but holding his finger in the stream that spouted from the vessel, received a shock also in that finger. From this and fundry other experiments, I am induced to believe, that the *gymnotus* has powers greatly superior to, or rather different from, those of the *torpedo*, which you have examined with so much attention. I have the honour to be, SIR,

Your most obedient

and very humble servant,

HUGH WILLIAMSON.

Philadelphia, Sept. 3, 1773

SOME weeks ago, a sea-faring man brought to this city a large eel, that had been caught in the province of Guiana, a little to the westward of Surinam. It had the extraordinary power of communicating a painful sensation, like that of an electrical shock, to people who touched it, and of killing its prey at a distance. As I have not heard that any other eel of this kind has ever been carried to any of our continental colonies, or that
any

any of them have been seen in Europe, I shall take the liberty, after I have given a short description of the fish, to relate such experiments as I made, or assisted in making, in hopes of discovering by what means it produced the effects I have mentioned. The eel was three feet seven inches long, and about two inches thick near the head. On a transient view, it resembled one of our common eels both in shape and colour; but its head was flat and its mouth wide, like that of a cat-fish, without teeth. A fin, which was above two inches broad, extended along its belly, from the point of its tail to within six inches of its head. This fin was almost an inch thick where it adhered to the body; the upper part of it was muscular, but of a very different texture from the muscular part of the body; the difference was obvious to the touch, for I had no opportunity of making any observations by dissecting the subject. It was a native of fresh water, and breathed at the interval of three or four minutes, by lifting its head to the surface.

EXPERIMENTS.

1. On touching the eel with one of my hands, I perceived such a sensation in the joints of my fingers as I received on touching a prime conductor or charged phial, when no circle was formed; or such as I have received, when a few sparks of the electric fluid have been conveyed through my fingers only.
2. On touching the eel more roughly, I perceived a similar effect in my wrist and elbow.
3. Touching the eel with

with an iron rod, twelve inches long, I perceived the like sensation in the joints of the thumb and fingers with which I held the metal.

4. While another person provoked the eel by touching it, I put my hand into the water at the distance of three feet, and felt such a sensation in the joints of my fingers as when I had touched the eel, but not so painful.

5. Some small fishes were thrown into the water where he was swimming; he killed them immediately, and swallowed them.

6. A cat-fish ^(a), that was at least one inch and an half thick, was thrown into the water where the eel was swimming; he killed it also, and attempted to swallow it, but could not.

7. In order to discover whether the eel killed those fish by an emission of the same fluid with which he affected my hand when I had touched him, I put my hand into the water, at some distance from the eel; another cat-fish was thrown into the water; the eel swam up to it, but presently turned away, without offering any violence. After some time he returned; when, seeming to view it for a few seconds, he gave it a shock, by which it instantly turned up its belly, and continued motionless; at that very instant I felt such a sensation in the joints of my fingers as in experiment 4.

8. A third cat-fish was thrown into the water, to which the eel gave such a shock, that it turned on its side, but continued to give signs of life. The eel seeming to observe this, as it was turning away, immediately returned, and struck it quite motionless. I could easily perceive that the last

(a) The Bayre de rio of Marcgrave.

shock was more severe than the former. The eel never attempted to swallow any of those fish after the first, though he killed many of them; and I always observed, that when he was going to kill one, he swam directly up to it, as if he was going to bite it; that when he came up, he sometimes paused before he gave the shock, at other times he gave the shock immediately. When we removed any of those cat-fish, though apparently dead, into water in another vessel, they presently recovered. Fish that are stunned by a small electrical shock were found to recover in the same manner.

9. Touching the eel, so as to provoke it, with one hand, and at the same time holding my other hand in the water, at a small distance, a shock passed through both my arms, as in the case of the Leyden experiment.

10. I put the end of a wet stick into the water, and holding it with one hand, I touched the eel with the other; a shock passed through both arms as before.

11. Taking another gentleman in company by the hand, he touched the eel, while I held one of my hands in the water; the shock passed through us both.

12. Instead of putting my hand into the water, at a distance from the eel, as in the last experiment, I touched its tail, so as not to offend it, while my assistant touched its head more roughly; we both received a severe shock.

13. Eight or ten persons, taking hands, stood in a circular form; the first in the series touched the eel, while the last put his hand into the water, at some distance from it; they all received a gentle shock.

14. The above experiment

ment was repeated with no other variation than that the last person touched the eel's tail, while the first touched its head; they all received a severe shock. 15. Another gentleman and myself, holding the extremities of a brass chain, one of us put his hand into the water, while the other touched the eel, so as to offend it; the shock passed through us both. 16. I wrapped a silk handkerchief round my hand, and touched the eel with it, but received no shock; although another gentleman felt the shock, who, at the same time, put his hand into the water, at some distance from the eel. 17. A great variety of other experiments were made by two persons, one touching the eel near its head, the other putting his hand into the water, or touching it near the tail, forming a communication at the same time between their hands, which were out of the water, by pieces of charcoal, rods of iron or brass, a piece of dry wood, glass, silk, &c. The uniform result of all those experiments was, that whatever uses to convey the electrical fluid would also convey the fluid discharged by the eel; and *vice versa*, a brass chain, that had very many links in it, would not convey it, unless when the shock was severe, or the chain tense. 18. One of the company being insulated on glass bottles, received several shocks from the eel; but he exhibited no marks of a *plus* state of electricity, nor would cork-balls, suspended by silken threads, give any marks of it, either when they were suspended over the eel's back, or touched by the insulated person at the instant he received the shock. 19.

A person, holding a phial in one hand properly lined and coated for electrical experiments, put his hand to the tail of the fish, while an assistant, holding a short wire in one hand that communicated with the inside of the phial, grasped the fish near its head, so as to receive a severe shock in his hand and arm, but it passed no further.

20. Two pieces of brass wire, about the thickness of a crow's quill, were screwed, in opposite directions, into a frame of wood, so as to come within less than the hundredth part of an inch of contact; they were rounded at the point. I held the remote end of one of those wires, while an assistant held the other; in the mean while, one of us putting his hand into the water near the eel, the other touched it so as to receive a shock. We repeated this experiment fifteen or twenty times with different success: when the points of the wires were even screwed asunder, to the fiftieth part of an inch, the shock never passed in the circle; but when they were screwed up within the thickness of double-post paper, the shocks, such of them as were severe, would pass through us both; in which case, they doubtless leaped from the point of one wire to the other, though we were not so fortunate as to render the spark generally visible. But it should be observed, that the eel on which we made these experiments, was not easily provoked, and appeared to be in bad health. I have frequently passed my hand along its back and sides from head to tail, and have lifted part of its body above the water, without tempting it to make any defence. Dr. BANCROFT tells us, that such eels in

Guiana

Guiana have flocked his hand at the distance of some inches from the surface of the water. Perhaps fire emitted by eels lately taken, might be rendered visible.

From the above experiments it appears: 1. That the Guiana eel has the power of communicating a painful sensation to animals that touch or come near it. 2. That this effect depends entirely on the will of the eel; that it has the power of giving a small shock, a severe one, or none at all, just as circumstances may require. 3. That the shock given, or the painful sensation communicated, depends not on the muscular action of the eel, since it shocks bodies in certain situations at a great distance; and since particular substances only will convey the shock, while others, equally elastic or hard, refuse to convey it. 4. That the shock must therefore depend upon some fluid, which the eel discharges from its body. 5. That as the fluid discharged by the eel affects the same parts of the human body that are affected by the electric fluid; as it excites sensations perfectly similar; as it kills or stuns animals in the same manner; as it is conveyed by the same bodies that convey the electric fluid, and refuses to be conveyed by other bodies that refuse to convey the electric fluid, it must also be the true electrical fluid; and the shock given by this eel must be the true electrical shock.